CLAIMS

1. A method of image processing comprising:

receiving first and second images representative of the same object viewed from a first and a second view point;

storing for each point in an array of points in said first image, an estimated transform required to match a portion of said first image identified by said point corresponding to part of said object to the portion of said second image representative of the same part of said object;

identifying an initial seed point within said array and adding data identifying said seed point to a queue of data identifying points to be processed; and

sequentially processing each of points identified by said queue, by:

adding data to the end of said queue identifying points in said array which are adjacent to the point identified by data at the head of the queue and for which no calculated transform has been determined;

utilising said stored estimated transform for the point identified by data at the head of the queue to determine a calculated transform for said point to match the portion of said first image identified by said point to said corresponding portion of said second image; and

updating said stored estimated transforms for adjacent points in said array to said point for which a calculated transform is determined utilising said calculated transform.

2. A method in accordance with claim 1 wherein said portion of said first image identified by a point comprises a portion of said image centred on said point.

3. A method in accordance with claim 2 wherein said updating of stored estimated transforms comprises:

determining a first value indicative of the correspondence between said portion of said first image identified by said point and a portion of said second image identified by applying said stored estimated transform to said portion of said first image;

determining a second value indicative of the correspondence between said portion of said first image identified by said point and a portion of said second image identified by applying said calculated transform for said adjacent point to said portion of said first image; and

if said second value is indicative of a closer correspondence, replacing said stored estimated transform for said point with said calculated transform for said adjacent point.

4. A method in accordance with claim 3 wherein said first and said second images comprise grey scale images and said first and said second values comprise calculated difference in grey scale values between said portion of said first image and said identified portion of said second image.

5. A method in accordance with claim 1 further comprising storing data identifying in said array the number of times data, each point is added to said queue and only adding data to said queue identifying a point if the said point has been added to said queue fewer than a predetermined number of times.

6. A method in accordance with claim 1 wherein a stream of video images are received said stream of video images comprising pairs of images representative of the same object viewed from said first and said second view point, wherein said storage of an estimated transform for matching points in said pairs of images of said video stream comprises storing calculated transforms for said points in said array for a previous frame of images in said video stream.

7. A method in accordance with claim 1 wherein said determination of a calculated transform for a point comprises an iterative determination of a calculated transform, wherein the initial calculated transform for said first iteration corresponds to said stored estimated transform for said point.

8. A method in accordance with claim 7 wherein said iterative determination comprises determining at each iteration a value indicative of the correspondence between the portion of said first image identified by said point and a portion of said second image identified by applying said calculated transform for said iteration and aborting said calculation if said correspondence is greater than a predetermined threshold after a predetermined number of iterations.

9. A method in accordance with claim 7 wherein said iterative calculation further comprises at each iteration comparing a calculated iterative transform for said iteration with data identifying one or more transforms and aborting said calculation if said iterative

calculation matches said stored data.

10. A method in accordance with claim 7 wherein said iterative determination comprises at each iteration

determining a difference matrix identifying for each point in said portion of said first image identified by said point the difference in pixel values for said point and a corresponding point is said second image identified by applying to said points said calculated transform;

determining a derivative matrix identifying the rate of change of pixel values for said corresponding points in said second image; and

utilising said difference matrix and said derivative matrix to determine an updated transform.

11. A method in accordance with claim 10 wherein said determining a derivative matrix comprises:

for said first iteration determining said derivative matrix utilising said stored estimated transform; and

for subsequent iterations determining an estimated derivative matrix utilising the previous derivative matrix, and the differences between the previous and updated transforms and the differences between the previous difference matrix and an updated difference matrix calculated utilising said updated transform.

12. A method in accordance with any claim 1 further comprising:

when said queue is empty, identifying a further seed point within said array for which no calculated transform has been determined and adding data identifying said further seed point to said queue.

13. A method in accordance with claim 1 further comprising:

illuminating a point in space utilising three intersecting planes of light;

determining the relative positions of said first and second viewpoints and said intersecting planes of light;

providing an obstruction in the vicinity of said point;

obtaining first and second images of said obstruction illuminated by said intersecting planes of light;

processing said images to determine the relative positions of said first and second viewpoints to said illuminated point in space; and

utilising said determined transformations and positions to calculate the position of points in the surface of said object relative to said illuminated point in space.

14. A method in accordance with claim 13 wherein said obstruction has a striped appearance and said processing of images comprises:

processing said images of said object to determine the positions of points corresponding to illuminated portions of said stripes appearing in said images relative to said first view point;

identifying groups of points lying within planes; and calculating the position of said point in space from the point of intersection of said planes defined by the positions of said groups of points.

15. A method in accordance with claim 13 wherein said obstruction comprises a flat surface and said processing of images comprises:

identifying lines illuminated by said planes of light in said images; and

utilising the positions of the intersections of said lines in said images to determine the relative positions of said first and second viewpoints and said point in space.

16. A method in accordance with claim 15 further comprising:

moving said obstruction to a second position;

obtaining further images of said obstruction in said second position;

identifying lines illuminated by said planes of light in said images; and

utilising the positions of the intersections of said lines in said first and second images to determine the relative positions of said first and second view points in space.

17. A method in accordance with claim 13 further comprising:

storing data identifying points on a surface relative to a point in space;

determining a transformation required to match the surface identified by said calculated position of points with said stored surface.

18. A method in accordance with claim 17 wherein said determination comprises:

determining the projection of said stored points to said first view point;

determining for each of said projected stored points, the closest points in said array to said projected points; and

calculating said transformation for said surface on the basis of the transformations

required to match each of said stored points to the points in space represented by the data for the points in the array determined to be closest to the respective projections of the stored points.

19. A method in accordance with claim 17 further comprising generating movement instructions to cause the surfaces of the object in said images to be aligned relative to said illuminated point in the same manner as said stored surface is aligned relative to a point in space.

20. A method in accordance with claim 17 further comprising generating an activation signal when said calculated transformation is indicative of a transformation of less than a predetermined distance.

21. A method in accordance with claim 1 further comprising:

obtaining model data indicative of the surface of said object viewed from a third view point;

utilising said calculated transforms to generate model data indicative of the surface of said object viewed from said first and second viewpoints; and

determining portions of said obtained model represented by said generated model by identifying projections of portions of said obtained model which project to said first view point and comparing the position of portions of said generated model corresponding to said projections.

22. A method in accordance with claim 21 further comprising deleting portions of said obtained model determined to be represented by said generated model wherein said portions of said obtained model are represented by data indicative of surfaces generated from data obtained from oblique images.

23. A method in accordance with claim 22 wherein said oblique images are determined utilising said calculated transforms for said points in said array in said first image corresponding to said portions of said model.

24. A method in accordance with claim 22 further comprising generating a combined model from said obtained and generated models from which portions have been deleted.

25. A method in accordance with claim 24 wherein said generation of a combined model comprises:

classifying points of overlap in said models;

generating new points representative of a boundary of said overlap between said models adjacent to said point if said classification of a point of overlap is of one or more predefined types;

deleting said points of overlap;

identifying portions of a combined model which define holes in a surface; and

generating a representation of the surface for said holes utilising the points in said combined model defining the boundaries of said holes.

26. A method in accordance with claim 25 wherein said utilising of the points defining boundaries comprises:

identifying a best fit plane utilising said boundary points;

modifying said boundary points so said to be in said identified plane; and

generating a model representation of the portion of said identified plane bounded by said modified boundary points.

27. Image processing apparatus comprising:

a receiver operable to receive first and second images representative of the same object viewed from a first and a second view point;

a data store operable to store for each point in an array of points in a said first image, an estimated transform required to match a portion of said first image identified by said point corresponding to part of said object to the portion of a said second image representative of the same part of said object received by said receiver;

a queue store operable to store data identifying points to be processed;

an identification unit operable to identify an initial seed point within a said array and adding data identifying said seed point to a queue of data identifying points stored in said queue store; and

processing unit operable sequentially processing each of points identified by a queue stored in said queue store, by:

adding data to the end of said queue stored in said queue store identifying points which are adjacent to the point identified by data at the head of the queue and for which no calculated transform has been determined;

utilising said estimated transform stored in said data store for the point identified by

data at the head of the queue stored in said queue store to determine a calculated transform for said point to match the portion of said first image identified by said point to said corresponding portion of a said second image received by said receiver; and

updating said estimated transforms stored in said data store for adjacent points in said array to said point for which a calculated transform is determined utilising said calculated transform.

28. An apparatus in accordance with claim 27 wherein said processing unit is operable to update estimated transforms stored in said data store for points by:

determining a first value indicative of the correspondence between said portion of a said first image received by said receiver identified by said point and a portion of a said second image received by said receiver identified by applying said estimated transform stored for said point by said data store to said portion of said first image;

determining a second value indicative of the correspondence between said portion of said first image received by said receiver identified by said point and a portion of said second image received by said receiver identified by applying said calculated transform for said adjacent point to said portion of said first image; and

if said second value is indicative of a closer correspondence, replacing said stored estimated transform for said point with said calculated transform for said adjacent point.

29. An apparatus in accordance with claim 28 wherein said receiver is operable to receive first and said second images comprising grey scale images and said processing unit is operable to calculate as said first and said second values, calculated difference in grey scale values between said portion of said first image and said identified portion of said second image.

30. An apparatus in accordance with claim 27 wherein said data store is further operable to store for each point data identifying in said array the number of times data, each point is added to said queue, said processing unit being operable to add data to said queue identifying a point only if the said point has been added to said queue fewer than a predetermined number of times.

31. An apparatus in accordance with claim 27 wherein said receiver is operable to receive a stream of video images comprising pairs of images representative of the same object viewed from said first and said second view point, wherein said data store is responsive to receipt of

a new pair of images to store an estimated transform for matching points in said pairs of images of said video stream comprising calculated transforms for said points in said array for the previous frame of images in said video stream.

32. An apparatus in accordance with claim 27 wherein said processing unit is operable to determine a calculated transform for a point by performing an iterative determination of said calculated transform, wherein the calculated transform for said first iteration corresponds to said estimated transform for said point stored in said data store.

33. An apparatus in accordance with claim 32 wherein said processing unit is operable to determine at each iteration a value indicative of the correspondence between the portion of a said first image identified by said point and a portion of a said second image identified by applying said calculated transform for said iteration and aborting said calculation if said correspondence is greater than a predetermined threshold after a predetermined number of iterations.

34. An apparatus in accordance with claim 32 wherein said processing unit is operable to compare at each iteration a calculated iterative transform for said iteration with data identifying one or more transforms and aborting said calculation if said iterative calculation matches said stored data.

35. An apparatus in accordance with claim 32 wherein said processing unit is operable to determine at each iteration:

a difference matrix identifying for each point in a said portion of said first image identified by said point the difference in pixel values for said point and a corresponding point is said second image identified by applying to said points said calculated transform;

a derivative matrix identifying the rate of change of pixel values for said corresponding points in said second image; and

an updated transform determined utilising said difference matrix and said derivative matrix.

36. An apparatus in accordance with claim 34 wherein said processing unit is operable to determine a derivative matrix for a first iteration utilising said stored estimated transform; and

for subsequent iterations determine a derivative matrix utilising the previous

derivative matrix, and the differences between the previous and updated transforms and the differences between the previous difference matrix and an updated difference matrix calculated utilising said updated transform.

37. An apparatus in accordance with claim 27 wherein said processing unit is operable when said queue is empty to cause said identification unit to identify a further seed point within said array for which no calculated transform has been determined and adding data identifying said further seed point to said queue stored in said queue store.

38. An apparatus in accordance with claim 27 further comprises:

lasers operable to identify a point in space by illuminating said point utilising three intersecting planes of light;

a determination unit operable to determine the relative positions of said first and second viewpoints and said intersecting planes of light; and

an obstruction provided in the vicinity of said identified point; wherein received images of said obstruction illuminated by said lasers received by said receiver are utilised to determine the relative positions of said first and second viewpoints to said illuminated point in space.

39. An apparatus in accordance with claim 38 wherein said obstruction has a striped appearance and said processing unit is operable to:

process said images of said object received by said receiver to determine the positions of points corresponding to illuminated portions of said stripes appearing in said images relative to said first view point; and to

identify groups of points lying within planes; and calculate the position of said point in space from the point of intersection of said planes defined by the positions of said groups of points.

40. An apparatus in accordance with claim 38 wherein said obstruction comprises a flat surface and said processing unit is operable to:

identify lines illuminated by said planes of light in images received by said receiver; and

to utilise the positions of the intersections of said lines in said images to determine the relative positions of said first and second viewpoints and said point in space.

41. An apparatus in accordance claim 38 further comprising:

a model store operable to store data identifying points on a surface relative to a point in space; and

a calculation unit operable to determine a transformation required to match a surface identified by said calculated position of points calculated by said processing unit utilising said calculated transformations and a surface identified by data stored in said model store.

42. An apparatus in accordance with claim 41 wherein said calculation unit is operable to:

determine the projection of said calculated points to a defined view point associating said points identified in said stored model in said model store with points of an array associated with said view point;

determine for each of said projected calculated points, the closest points in said array to said projected points; and

calculating said transformation for said surface on the basis of the transformations required to match said calculated points to the points in space represented by the stored data in said model store associated with the points in said array determined to be closest to the respective projections of the calculated points.

43. An apparatus in accordance with claim 41 wherein said calculation unit is operable to generate movement instructions to cause the surfaces of the object in said images to be aligned relative to said illuminated point in the same manner as said surface represented by data stored in said model store is aligned relative to a point in space.

44. An apparatus in accordance with claim 41 wherein said calculation unit is operable to generate an activation signal when said determined transformation is indicative of a transformation of less than a predetermined distance.

45. An apparatus in accordance with claim 27 wherein said apparatus further comprises:

a merging unit operable to obtain model data indicative of the surface of said object viewed from a third view point; and

determine portions of said obtained model represented by a said generated model generated utilising said transforms calculated by said processing unit, by identifying projections of portions of said obtained model which project to said first view point and

comparing the position of portions of said generated model corresponding to said projections.

46. An apparatus in accordance with claim 45 further comprising a deletion unit operable to delete portions of said obtained model determined by said merging unit to be represented by said generated model wherein said portions of said model are represented by data indicative of surfaces generated from data obtained from oblique images.

47. An apparatus in accordance with claim 46 wherein said deletion unit is operable to determine whether data is obtained from oblique images utilising said calculated transforms for said points in said array in said first image corresponding to said portions of said model.

48. An apparatus in accordance with claim 46 wherein said merging unit is operable to generate a combined model from said obtained and generated models from which portions have been deleted.

49. A method of image processing comprising:

obtaining a stream of video images representative of the same object viewed from a first and a second view point;

for each pair of frames representative of said object determining for an array of points of an image from said first view point corresponding points in an image from said second view point representative of the same part of said object; and

generating a model of the surface of said object utilising the correspondence between points in said pairs of frames, wherein said determination of corresponding points comprises:

storing for each point in an array of points in said first image an estimated transform received to match a portion of said first image identified by said point corresponding to part of said object to the portion of said second image representative of the same part of said object and utilising said estimated transforms to determine said corresponding parts, wherein the initial estimated transforms comprise calculated transforms for matching corresponding points in an earlier pair of image frames.

50. A method of determining corresponding portions of models representing the surface of the same object comprising:

obtaining model data representative of the surface of an object viewed from a first and a second view point;

determining a projection of model data representative of an object viewed from said first object to said second view point;

determining for said projected data whether any portion of said model data representative of said object viewed from said second view point also projects to the same portion of said second view point; and

determining for portions of said models projecting to the same portion of said view point, whether the surfaces represented by said portions of said models are close to one another.

51. A method of aligning two models of surfaces comprising:

obtaining model data representative of a first and a second model;

determining for a plurality of points represented by said first model, the projection of said points to a predefined view point;

for said projected points, determining for said second model, the points of said second model, which project to said predefined view point in the vicinity of projected points from said first model; and

determining an alignment transform for aligning said models on the basis of determined transforms for matching the points projected from said first model to the closest points projected from said second model.

52. A patient positioning system comprising:

means for obtaining a stream of images of a patient as a mechanical couch from a plurality of viewpoints;

means for processing frames of images from said plurality of viewpoints to generate for each frame a model of the surface of said patient; and

means for determining patient positioning instructions on the basis of models generated by said means for processing.

53. Apparatus for obtaining synchronous and asynchronous images of an object from a plurality of viewpoints, said apparatus comprising:

a plurality of imaging devices, each imaging device comprising an array of charge coupled devices, a shutter and a timing unit;

a control unit operable to vary the timing of the opening of said shutters and the read out of image data from said imaging devices; and

a frame store operable to receive image data from said imaging devices;

wherein the timing unit of one of said imaging devices is operable to synchronise the read out of image data from said charge coupled devices and said control unit is operable to initiate the opening of said shutters such that image data obtained from said arrays of charge coupled devices corresponds to images obtained whilst said all of said shutters are open or to delay the opening of said shutters of at least one imaging device relative to the others wherein the read out of data is synchronised with the earliest opening of said shutters.

54. Apparatus in accordance with claim 53, wherein said control unit further comprises recognition means for identifying the presence of an object in image data obtained from said arrays of charge coupled devices wherein said control unit is operable to initiate asynchronous image capture when the present of an object is detected.

55. Modelling apparatus comprising:

apparatus for obtaining image data in accordance with claim 53; and

image processing apparatus in accordance claim 27.

56. In a method of generating models of the surface of an individual comprising:

projecting a speckle pattern onto an individual;

obtaining a pair of images of said projected speckle pattern viewed from different view points; and

generating a model of the surface of said individual by matching corresponding portions of said pair of images;

the improvement comprising:

obtaining images;

determining the proportion of said images of said projected speckle pattern representative of saturated colour; and

adjusting the exposure control if said proportion exceeds a threshold value.

57. In a method of generating models of the surface of an individual comprising:

projecting a speckle pattern onto an individual;

obtaining a pair of images of said projected speckle patter viewed from different view points; and

generating a model of the surface of said individual by matching corresponding

portions of said pair of images;

the improvement comprising:

storing a plurality of exposure settings in association with data indicative of skin type;

inputting a skin type for said individual; and

obtaining said images of said projected speckle pattern utilising the exposure setting associated with said input skin type.

58. A method of patient positioning and monitoring comprising:

projecting a speckle pattern onto a patient;

obtaining images of said projected speckle viewed from different view points;

generating a first model of the surface of said patient by matching corresponding portions of speckle pattern appearing in said images;

utilising said first model to generate control commands for positioning said patient;

obtaining further images of a projected speckle pattern; and

generating further models of said patient utilising said further images.

59. A method in accordance with claim 58 wherein the projection of a speckle pattern for said first model comprises utilising a flash light source and wherein the projection of a speckle pattern for said further models comprises utilising a non-flash light source.

60. A method in accordance with claim 58 wherein the further images obtained of a projected speckle pattern comprise lower resolution images than said images utilised to generate said first model.

61. A method in accordance with claim 58 wherein the further images obtained of a projected speckle pattern comprise images corresponding to part of the field of view of images utilised to generate said first model.

62. Apparatus for combining two wire mesh models comprising:

a model store configured to store model data representative of three dimensional co-ordinates of a first and second wire mesh model of a surface;

an overlap identifier operable to identify portions of wire mesh models stored in said model store representative of the same portions of a surface; and

a processing module operable to:

delete from first and second wire mesh models stored in said model store model data representative of vertices of the boundary of one said models where triangles including said vertices are completely represented in part of said other model;

classify vertices at the boundary of a model on the basis of whether said vertices define part of one or more triangles and the number of edges the triangle defines by said vertices overlap;

generate new co-ordinates for shared points on the boundary between said models on the basis of the classification of said vertices; and

delete said classified vertices.

63. Apparatus in accordance with claim 62, wherein said processing module is operable to generate new co-ordinates only when a co-ordinate is classified as defining a vertex of one or more triangles where the edges of individual triangles only overlap a single edge of triangles defined in said other model.

64. Apparatus in accordance with claim 63, wherein said processing module is operable to modify the co-ordinate data of points defining the outline of holes in said combined wire mesh models by:

determining a best fit plane for points defining the outline of a hole; and

modifying said co-ordinate data for said points so as to cause said points to be represented by co-ordinates of points lying within said plane.

65. In an apparatus for generating models of the surface of an individual comprising:

a projector operable to project a speckle pattern onto an individual;

a first and a second camera operable to obtain a pair of images of said projected speckle pattern viewed from different view points; and

a model generation unit operate to generate a model of the surface of said individual by matching corresponding portions of said pair of images;

the improvement comprising:

an exposure control unit operable to determine the proportion of said images of said projected speckle pattern representative of saturated colour and adjust the exposure control of said first and second cameras if said proportion exceeds a threshold value.

66. In an apparatus for generating models of the surface of an individual comprising:

a projector operable to project a speckle pattern onto an individual;

a first and second camera operable to obtain a pair of images of said projected speckle patter viewed from different view points; and

a model generation unit operable to generate a model of the surface of said individual by matching corresponding portions of said pair of images;

the improvement comprising:

a data store storing a plurality of exposure settings in association with data indicative of skin type;

an input module enabling user input of data identifying a skin type for an individual; and

an exposure control unit for setting the gain control settings of said first and second camera utilising the exposure settings associated with said skin type identified by user input.

67. A method of combining two wire mesh models comprising:

storing model data representative of three dimensional co-ordinates of a first and second wire mesh model of a surface;

identifying portions of stored wire mesh models representative of the same portions of a surface;

deleting from said stored first and second wire mesh models model data representative of vertices of the boundary of one said models where triangles including said vertices are completely represented in part of said other model;

classifying vertices at the boundary of a model on the basis of whether said vertices define part of one or more triangles and the number of edges the triangle defines by said vertices overlap;

generating new co-ordinates for shared points on the boundary between said models on the basis of the classification of said vertices; and

deleting said classified vertices.

68. A method in accordance with claim 67, wherein said to generating new co-ordinates occurs only when a co-ordinate is classified as defining a vertex of one or more triangles where the edges of individual triangles only overlap a single edge of triangles defined in said other model.

69. A method in accordance with claim 68, further comprising modifying the co-ordinate

data of points defining the outline of holes in said combined wire mesh models by:

determining a best fit plane for points defining the outline of a hole; and

modifying said co-ordinate data for said points so as to cause said points to be represented by co-ordinates of points lying within said plane.

70. A method of treating a patient by irradiating radiation onto said patient, the method comprising:

obtaining images of a patient on a mechanical couch viewed from different view points;

generating a model of the surface of the patient utilising said images;

positioning the patient by generating control commands for said mechanical couch on the basis of a comparison of said generated model and stored model of the surface of said patient;

obtaining further images of a patient on said mechanical couch viewed from different view points as positioned on the basis of said control commands;

generating further models of the surface of the patient utilising said images; and

selectively irradiating said patient on the basis of a comparison of said further models with said stored model.

71. A data carrier storing computer implementable process steps for causing a programmable computer to perform an image processing method in accordance with claim 1.

72. A data carrier storing computer implementable process steps for generating within a programmable computer an image processing apparatus in accordance with claim 27.

73. A data carrier in accordance with claim 71 comprising a computer disc.

74. A data carrier in accordance with claim 71 comprising an electric signal transferred via the Internet.

75. A computer disc in accordance with claim 73 wherein said computer disc comprises an optical, magneto-optical or magnetic disc.